USPTO Economic Working Paper

Office of Chief Economist, U.S. Patent and Trademark Office

U.S. Department of Commerce

Perspectives on the growth in Chinese patent applications to the USPTO

Alan Marco
Richard Miller
Jay Kesan

Working Paper No. 2014-1
http://www.uspto.gov/ip/officechiefecon/publications.jsp#heading-3

February 2014

Office of Chief Economist
U.S. Patent and Trademark Office
600 Dulany Street
Alexandria, VA 22314

Perspectives on the growth in Chinese patent applications to the USPTO

Alan Marco
U.S. Patent and Trademark Office
Alexandria, Virginia

Rick Miller
U.S. Patent and Trademark Office
Alexandria, Virginia

Jay Kesan
University of Illinois
College of Law
Champaign, Illinois

February 2014

Abstract

The purpose of this working paper is to investigate utility patent applications to the US Patent and Trademark Office (PTO) from inventors residing in China. It first focuses on the growth in the numbers of applications, putting this growth in context by comparing it to other important emerging economies. The paper considers how the technology mix of applications from China and the other comparison countries has evolved and how allowance rates have changed over the past decade. The paper also puts the recent growth of Chinese utility patent applications into historical perspective by comparing it to 1) the growth in South Korean applications for the 10-year period starting from the mid-1980s, and 2) the growth in Indian applications for the 10-year period starting in the late 1990s. We find that the growth in the number of applications from China has greatly outpaced the overall growth in applications from both domestic and foreign filers. It has also outpaced the growth in applications from other important emerging economies such as India and Brazil. At the same time, the technology mix of Chinese applications has become more heavily weighted toward communications and computing. We found a similar result for the applications which originated from the other major emerging economies. Finally, over the past 6 years, the allowance rate for Chinese applications has begun to converge with the allowance rate for Japanese and South Korean applications. The historical comparisons indicate that the growth in applications from China is not unique. Chinese growth has been very similar to the growth in applications to the PTO from South Korea starting in the mid-1980s. Overall, the results indicate that China is taking the next step in the development process from the production of standardized goods to the development of new products and processes.

USPTO Economics Working Paper No. 2014-1.
Keywords: Patents, China
JEL Classification Numbers: O34

1 Introduction

The growth of the Chinese economy since the beginning of the new century has been impressive. Adjusting for changes in the value of the Yuan over this period, China's GDP has roughly tripled. This growth has coincided with a significantly increased demand for intellectual property protection on the Chinese mainland, particularly for the patenting of new inventions. According to data from the World Intellectual Property Organization, the number of patent applications from Chinese residents to China's State Intellectual Property Office (SIPO) grew at an average annual rate of 29 percent from 25,346 in 2000 to 415,829 in 2011.[1] Even more impressive, the number of patent applications that large and medium enterprises in high-technology industries submitted to SIPO increased at an annual rate of 38 percent over the same time period, from 2,245 in to 77,725.[2] In fact, SIPO currently receives more patent applications than any other patent granting authority, and 80 percent of all applications to SIPO come from Chinese residents. Slightly less than 50 percent of all applications to the US Patent and Trademark Office (PTO) come from US-based inventors.

The purpose of this working paper is to provide some data on utility patent applications to the PTO from inventors residing in China.[3] It first focuses on the growth in the numbers of applications, comparing this growth to trends for Japan and South Korea, as well as for other important emerging economies.[4] The paper also considers how the technology mix of applications from China and the other comparison countries has evolved and how allowance rates have changed over the past decade.[5] The results indicate that, since 2000, the growth in applications from China has greatly outpaced the growth in applications from Japan, South Korea, and the other emerging economies. Over this time period, the technology mix of Chinese applications has become more heavily weighted toward communications and computing. We found a similar result for the applications that originated from the other emerging economies. Finally, over the past six

[1] See WIPO website at http://www.wipo.int/ipstats/en/statistics/country_profile/countries/cn.html. Website was last accessed on December 16, 2013.

[2] These numbers come from the *2012 China Statistics Yearbook on High Technology Industry*, which was compiled by China's National Bureau of Statistics, National Development and Reform Commission, and Ministry of Science and Technology. The high technology industries include the manufacture of medicines, aircrafts and spaceships, electronic and communication equipment, computers and office equipment, medical equipment, and measuring instruments.

[3] We focus on applications to the PTO, because we wish to compare Chinese patenting activity with the patenting activity of inventors in other countries. Because examination standards differ across patent offices, comparing domestic filings in China with domestic filings in other countries may lead to spurious findings. By focusing just on PTO filings, we are able to control for examination standards.

[4] The "other important emerging economies" group consisted of Argentina, Brazil, India, Indonesia, Mexico, Turkey, Russia, and South Africa.

[5] The definitions of technology mix and allowance rate are discussed in Section 2 below.

years, the allowance rate for Chinese applications has begun to converge with the allowance rate for Japanese and South Korean applications.

In the final section, the paper puts the growth of Chinese utility patent applications into historical perspective. It compares the recent growth in Chinese applications (from 1997 to 2007) to 1) the growth in South Korean applications for the 10-year period starting in 1986, and 2) the growth in Indian applications for the 10-year period starting in 1998.[6] Finally, this paper considers the evolution of the technology mix and allowance rates in each case over these periods of intense growth in patenting activity. The rates of growth for the South Korean and Chinese cases are quite similar and both are much higher than the growth rate of Indian applications. The results remind us that the growth in applications from China is not unique historically, and that the Chinese are following a strategy that has already been quite successful for other large East Asian countries.

2 Data and Methods

Data

The data used in this study are from the PTO's internal Patent Application Location and Monitoring (PALM) system. Patent examiners use the PALM system to monitor the progress of patent application examination. The PALM data include the following information: 1) the date that each application was received by the PTO; 2) the identities of the inventors; 3) the addresses of the inventors; 4) the examining unit to which the application is assigned; and 5) the ultimate disposal state (allowed, abandoned, or pending) of the application. All applications received by the PTO, including those that have never been published, are present in PALM.[7] In the analyses that follow, we consider only regular utility patent applications, not design patent applications or provisional applications.

Determining Country of Origin

In this study, we define an application's country of origin as the country of residence of the application's first-named inventor. For example, we consider an application to be from China if the first-named inventor's residence is listed as mainland China. The Chinese applications included in the study do not include applications where the first-

[6] These exact time periods were chosen because they were the periods of greatest growth in the number of applications from each country. We are unable to include Japan in the historical analysis, because its period of greatest growth would have started in the mid- to late-1950s and our data are limited for the period prior to 1963.

[7] In this way, PALM differs from the public version of the Patent Application Information Retrieval (PAIR) system. With rare exceptions, Public PAIR only includes applications that have been made public due to the issuing of a patent, or the publication of the application.

named inventor was from Hong Kong, Macau, or Taiwan. The applications can, however, include cases where a foreign national, who is living in China, is the first-named inventor. Also, the Chinese applications include many cases in which Chinese nationals, living in China but working for multinational enterprises, are first-named inventors. The same approach is used to determine which applications originated from each of the comparison countries.[8]

Defining the Comparison Groups

There are two comparison groups for the first analysis, which focuses on patent applications from 2000 onward. The first comparison group consists of applications where the first-named inventor resided in either Japan or South Korea. The second comparison group consists of applications where the first-named inventor came from one of eight major emerging economies. The eight economies were chosen because they met two criteria. First, each was defined as emerging by the International Monetary Fund (IMF). Second, each is a member of the Group of 20 (G20).[9] Only eight countries, other than China, meet both of these criteria: Argentina, Brazil, Mexico, India, Indonesia, Turkey, Russia, and South Africa.

For the historical comparisons in the final section of this report, the comparison groups consist of 1) applications where the first-named inventor resided in South Korea and 2) applications where the first-named inventor resided in India. We chose the South Korean comparison group because the growth in the numbers of South Korean applications between 1986 and 1996 was very similar to the growth in Chinese applications from 1997 to 2007 (the fastest period of growth in the number of applications from China, albeit from a very small base). We chose the Indian comparison group because the growth in applications from that country has greatly exceeded the growth in applications from the other major emerging economies outside of China.

Defining Technology Mix

To examine the technology mix of incoming applications, we consider the technology centers (TCs) at the PTO to which they are assigned.[10] Ultimately we decided on the following six technology categories:

---

[8] As an alternative, one could pick the nationality of the previous foreign document, if one exists. In other words, an application with no parent application would be considered a US filing. An application with a previous foreign priority application filed in China would be considered a Chinese filing. We have replicated the analyses with this definition and found no discernible difference from the results we report below.

[9] A list of IMF emerging economies can be found in Figure 2 at http://www.imf.org/external/pubs/ft/weo/2012/update/02/index.htm. (Last accessed on December 17, 2013) A list of G20 countries can be found at http://www.g20.org/about_g20/g20_members (last accessed on December 17, 2013).

[10] TCs are groups of examining art units.

- Biotechnology and organic chemistry (BIO) – TC 1600[11]
- Chemical and materials engineering (CHEM) – TC 1700[12]
- Computers and communications (COMP)[13] – TCs 2100, 2400, and 2600[14]
- Semiconductors, electrical and optical systems and components (SEMI) – TC 2800[15]
- Transportation, construction, electronic commerce, agriculture, national security and license & review (TRANS) – TC 3600[16]
- Mechanical engineering, manufacturing, products (MECH) – TC 3700[17]

Measuring Concentration of the Technology Mix

While examining the changes in the technology mix, this paper also considers changes in the relative concentration of the technology mix over time for each country (or group of countries) of interest. To do so, we use the Herfindahl-Hirschman index (HHI), a measure commonly used by economists when examining market concentration. To calculate the index, we first calculate the share of all applications in each of the six technology areas. We then square each of these shares and sum them. Higher values of the index indicate higher levels of concentration. Given that we have six technology areas, the smallest value the index can take on is 0.167, which would indicate a uniform distribution of applications across the six technology areas. The largest value that the index can take on is 1, which would indicate that all of the applications were assigned to just one of the six technology areas.

Measuring Allowance Rates

The allowance rates reported in this paper were calculated for the set of all applications that had either been abandoned or allowed as of February 2013. The allowance rates are

---

[11] In prior years, TCs 1200 and 1800 (no longer in use) mapped to the BIO area,
[12] In prior years, TCs 1100, 1300, and 1500 (all no longer in use) mapped to the CHEM area.
[13] In the areas of computers and telecommunications, the TCs have not been stable since 2000. Currently, these types of patent applications are assigned to one of the following three TCs:

- 2100 – Computer Architecture, Software, and Information Security
- 2400 – Computer Networks, Multiplex Communication, Video Distribution and Security
- 2600 – Communications

TC 2400 is relatively new; applications that would commonly be assigned to that TC would have been assigned to either 2100 or 2600 earlier in the decade. Thus, we decided to combine these three TCs into one category called "computers and communications."
[14] In prior years, TCs 2300 and 2700 (both no longer in use) mapped to the COMP area.
[15] In prior years, TCs 2200 and 2500 (both no longer in use) mapped to the SEMI area. Prior to 1998, TC 2100 mapped to the SEMI area instead of the COMP area.
[16] In prior years, TCs 3100 and 3500 (both no longer in use) mapped to the TRANS area.
[17] In prior years, TCs 3200, 3300, and 3400 (all no longer in use) mapped to the MECH area.

reported for the year of application rather than the year of disposal. As an example, consider a case where the PTO received 10,000 applications from inventors in a given country in 2006. Suppose that by February 2013, 4,500 of the applications had been issued as a patent, 4,500 had been abandoned, and 1,000 were still pending. The allowance rate for 2006 would be 50 percent (4,500 total issued patents divided by 9,000 total disposals)..

3 Patent Applications from China

The Growth in the Number of Applications to the PTO

Figure 1 compares the growth in the number of the PTO applications from mainland China to applications from the other major emerging economies since 2000. The PTO received 422 patent applications from mainland China in 2000, as compared to 1,500 applications from the eight other major emerging economies.[18] By 2006, the PTO was receiving 23 percent more applications from China than from the other eight emerging economies combined. By 2011, the number of applications from China was nearly 70 percent higher than the number of applications from the other emerging economies.

At the same time, the number of applications coming from China over this time period was still quite small compared to the number of applications coming from Japan and South Korea.[19] Japanese and South Korean inventors accounted for roughly 50,000 applications in 2000, with applications from those countries peaking at a little over 80,000 in 2007. After the financial crisis, the number of applications fell slightly, but was back above 77,000 by 2011. This growth in the number of applications since 2000 is comparable to the growth in the number of applications from US-based inventors during the same time period – roughly 50 percent over 11 years for an average annual growth rate of roughly 4 percent. At the same time the growth in the number of foreign applications to the PTO nearly doubled over the same 11-year period, reflecting an average annual growth rate of just over 6 percent.

However, even the rate of growth in foreign applications pales in comparison to the rate of growth in the number of applications from China. In Figure 2, we compare China's growth rate with those of the two comparison groups. The number of applications from the other eight major emerging economies grew at an average annual rate of roughly 12 percent, so that by 2011, the PTO received more than three times as many applications from these countries than it had received from them in 2000. Thus, the number of

[18] The other major emerging economies included Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey

[19] This explains why the numbers for this comparison group are not included in Figure 1.

applications from these countries grew at a rate greater than the number of all foreign applications. However, over this same time period, the number of applications from mainland China grew at an average annual rate of 31 percent. By 2011, the PTO was receiving 21 times as many applications from Chinese inventors than it had received in 2000.[20]

Evolution of the Technology Mix

Figure 3 illustrates that the rate of growth in the number of applications from China has not been uniform across technology areas. The highest rates of growth have come in computers and communications (COMP) and in semiconductors (SEMI). In these areas, the numbers of applications have grown at annual rates of 38 percent and 36 percent, respectively. The biotechnology area has experienced the least growth. Still, the number of applications in this technology area increased at an average annual rate of 20 percent between 2000 and 2011.

Panel (a) in Figure 4 illustrates the change in the technology mix of Chinese applications from the 2000-02 and the 2009-11 time periods. Given the results presented in Figure 3, it is not surprising that we see a shift away from the technology areas that have been growing least quickly (BIO, CHEM, and MECH) to the two fastest growing technology areas, COMP and SEMI. The change in the share of all applications assigned to COMP has grown much larger, from 24 percent at the beginning of the period to 39 percent at the end of the period.

For the sake of comparison, Panels (b) through (d) of Figure 4 show the changes in the technology mixes for three different comparison groups. Panel (b) shows the changes for the other major emerging economies, Panel (c) shows the changes for Japan and South Korea, and Panel (d) shows the changes for applications to the PTO from all countries (including domestic applications) for the same time period.

As was the case for China, the technology mix for the other major emerging economies has skewed more heavily toward COMP and away from the BIO, CHEM, and MECH areas. The share of all applications from these countries assigned to COMP has more than doubled over the past decade.

For Japan and South Korea, the share of applications assigned to COMP has grown, but less so than for either China or the emerging economies. From 2000 to 2002, 24 percent of the applications were in COMP. By the later time-period, this share had grown to 29 percent. Also, the technology area accounting for the greatest share of applications

[20] Interestingly, the average annual growth rate is very similar to the rate of growth in patent applications to SIPO from Chinese residents, which is roughly 29 percent.

continues to be SEMI, with a 34-percent share at the beginning of the period and a 35-percent share at the end of the period. The growth in the shares of the COMP and SEMI areas were offset by small decreases in the shares of the other technology areas. The relative stability of the technology mix for Japan and South Korea are likely a result of a greater level of maturity in those countries' economies.

As a final comparison, panel (d) of Figure 4 presents the change in the technology mix of all applications received by the PTO. Again, there is a small increase in the shares of applications in COMP and SEMI, but the result is not nearly as pronounced as the results for China and the other major emerging economies. The increased intensity in the COMP area by inventors in these emerging economies, including China, does not appear to be a broader trend. As illustrated in Figure 5, for China and the other emerging economies, there has been a much greater shift into the COMP and SEMI technology areas and away from the other areas.

Another way to examine the technology mix is to measure technological concentration. Figure 6 shows that the technological concentration of Chinese applications has increased over the past decade. In 2000, China's technology mix was not terribly concentrated in any one or two areas, with an HHI of 0.18. The same could be said for the technology mix for the other major emerging economies (HHI=0.17). By 2006, however, the technology mix of Chinese applications had become much more concentrated (skewed toward the COMP and SEMI areas). This is illustrated by the increase of the HHI to 0.27 by 2006. The technology mix of Chinese applications has maintained a comparable level of concentration ever since. There has also been an increase in the technology concentration of applications from the other emerging economies, although it has not been as pronounced. The HHI for these countries had increased to 0.23 by 2008, and has stayed in the 0.21 to 0.23 range since then. The technology mix concentration of Japanese and South Korean applications was high relative to those of the other comparison groups in the early part of the decade (from 2000 to 2005), but has also remained fairly consistent, rising from 0.235 to 0.25 over the time period.

In some ways the increase in developing countries' concentrations may seem strange. The conventional wisdom is that developing countries first develop technological capacities in particular focused areas, and then branch out into other areas. Nonetheless, the HHI metric shows a consistent pattern of increasing concentration for developing countries.

Allowance Rates

Given the enormous increase in the number of patent applications from China, it makes sense to question whether this increased activity has been at the cost of decreased

application quality. Figure 7 illustrates how the allowance rates have changed for Chinese applications as well as for the two comparison groups, Japan/South Korea and the eight major emerging economies.[21] Among the three groups discussed here, allowance rates have been highest for applications from Japan and South Korea. For applications that were received from these two countries in 2000, the allowance rate was slightly over 80 percent (as compared to roughly 66 percent for applications from China and the other major emerging economies). Allowance rates generally fell, regardless of origin, through 2007, but have been increasing since that time. However, what matters is the relative allowance rate, and the most important insight in Figure 7 is the fact that the allowance rate for Chinese applications has been steadily converging with the allowance rate for Japanese and South Korean applications, while diverging from the lower allowance rate for the other emerging economies. This may indicate that Chinese applicants are developing institutional expertise regarding how the system works at the PTO. It may also indicate that the mix of inventors has changed and that more applications are coming from Chinese inventors who are working for multinational enterprises

There are two issues to note with respect to the allowance rate results. The first issue relates to the fact that we are calculating the allowance rates only for applications that have been disposed; many of the applications filed in the later years are still pending. However, if many applications are still pending, it is unclear what the final allowance rate will be. Therefore we tested applications from the earliest cohorts to see how the allowance rate evolved as more applications were disposed. For applications filed between 2000 and 2002, we found no evidence that the final allowance rate (after almost all applications had been disposed) differed from the allowance rates for, say, the first 20 or 30 percent of applications disposed from each of those years. In essence, the allowance rate for disposed applications when only 20 or 30 percent of the applications have been disposed appears to be a good estimate of what the final allowance rate will be after all applications have been disposed. Thus, we feel confident that the convergence of allowance rates in the later years is not due to biased measures of the final allowance rates.

The second issue relates to the different technology mixes of the applications from different countries. Certain technology areas, such as biotechnology, exhibit lower allowance rates. Thus, overall allowance rates may change simply due to changes in the technology mix. We used multivariate statistical models to control for the differences in technology mix and the result regarding the convergence of the Chinese allowance rate to the Japanese/South Korean allowance rate did not change. After controlling for technology mix, we found that the allowance rate for the other major emerging

[21] Allowance rates are generally a function of several different factors such as the presence of examination backlogs and changes in patent office policies over time.

economies also converges toward that of Japan and South Korea. However, the rate of convergence is still greater for the Chinese applications (see Figure 8).

4 Historical Comparisons

In this section, we consider the growth in the number of Chinese patent applications to the PTO from 1997 through 2007. This period saw the highest 10-year growth in the number of such applications. We then consider two separate comparisons:

- South Korea (1986-1996): The first comparison is the growth in patent applications to the PTO from South Korea from 1986 to 1996. Again, this represents the largest 10-year growth in patent applications from South Korea.
- India (1998-2008): The second comparison is the growth in patent applications to the PTO from India from 1998 to 2008. This represents the largest 10-year growth in patent applications from India.

The Growth in the Number of Applications

In all three cases, the number of applications in the base year is quite small, ranging from 131 applications from China in 1996 to 158 applications from South Korea in 1986 to 164 applications from India in 1998. Figure 9 illustrates how quickly the numbers of applications from each of these countries grew over the following ten years. The growth in Chinese applications from 1996 to 2006 was quite similar to the growth in South Korean applications over the previous decade, especially through the first 8 years (through 2005 in the case of China). In each case the number of applications at the end of the period was roughly 30 times higher, which reflected a 40-percent average annual growth rate over 10 years. Even India, with its 30-percent average annual growth rate in applications from 1998 to 2008, is left lagging.[22]

Evolution of the Technology Mix

In Figure 10, we consider the evolution of the technology mix for applications received from each country over the 10-year period of interest. Panel (a) illustrates how the technology mix changed for Chinese applications. At the beginning of the period, the CHEM and SEMI technology areas were most important accounting for 25 percent and 22 percent of all applications, respectively. By the end of the period, the CHEM area accounted for only 9 percent of all applications, while the COMP area had grown from a

[22] The results do not change when one controls for the growth rate for all applications to the PTO. The number of applications to the PTO grew at an annual rate of 4.5 percent from 1986 through 1996, an annual rate of 5 percent from 1997 through 2007, and an annual rate of 4.75 percent from 1998 through 2008.

10-percent share to a 35-percent share. The BIO area had also become a smaller share of applications falling from 15 percent to 7 percent over the time period.

Panel (b) examines how the technology mix changed for Indian applications. In the late 1990s, applications from India were heavily concentrated in the BIO area. Roughly 45 percent of the applications were in that area. By the end of the time period, the Indian applications were still heavily concentrated in one area, but that area had switched from BIO to COMP. For the 2006 to 2008 period, the COMP technology area accounted for roughly half of all applications.

In Panel (c) we examine how the technology mix changed in South Korea during its initial period of rapid growth. Over this time period, the share of all applications in the SEMI area grew from 20 percent to 35 percent. During this same period, the shares of applications in the TRANS and MECH areas each fell by at least 30 percent.

Figure 11 illustrates what happened to the technology-mix concentrations in each country as compared to changes in the technology mix concentration for all regular utility applications to PTO.[23] The first result to consider is that in each case, after an initial drop the technology mix concentration rose steadily. For China, the HHI initially fell from 0.2 to 0.175 between 1997 and 1999, but then rose to 0.275 by 2006. For South Korea, the HHI initially fell from 0.24 to 0.19 between 1986 and 1988, but then rose to 0.25 by 1992 and fluctuated between 0.22 and 0.25 through 1996. The technology mix concentration was generally much higher for India. The HHI initially fell from 0.33 in 1998 to 0.26 in 2003, only to rise again to 0.34 by 2008. It is also worth noting that the technology mix of applications from China was generally the least concentrated of the technology mixes during their periods of fast growth, except toward the end of the ten-year period where China's technology mix concentration for 2006 and 2007 was slightly higher than the concentration for South Korea for 1995 and 1996.

Allowance Rates

Figure 12 presents technology area-adjusted allowance rates for South Korea (1986-96), China (1997-2007), and India (1998-2008). As the results in Figure 12 show, the allowance rate for South Korean applications generally increased while the allowance rates for Chinese and Indian applications generally decreased over the time periods of interest. However, it appears that these trends were driven by general trends in the overall allowance rate. If anything, the evolution of South Korean and Chinese allowance rates followed the evolution of the allowance rates for all applications to the PTO. The decrease in the allowance rate for Indian applications was more dramatic then the underlying decrease in the allowance rate for all applications to the PTO. Another pattern

[23] We again use the HHI, discussed in Section 2, to measure the technology mix concentration.

that emerges is that the technology area-adjusted allowance rate for South Korean applications from 1988 through 1996 was generally on par with the overall allowance rate at the PTO, while the allowance rate for Chinese applications from 1997 through 2007 was generally lower than the overall allowance rate. The allowance rate for Indian applications went from being much higher than average from 1998 to 2002 to being average by 2005.

5 Summary

The astronomical growth in the number of patent applications to SIPO from Chinese firms has been accompanied by similar growth in the number of applications to the PTO from Chinese inventors. The number of applications to the PTO from China grew at an average annual growth rate of 31 percent from 422 in 2000 to 8,619 in 2011. And the number of applications from China to the PTO was already growing steadily before the turn of the century. Between 1997 and 2007, the average rate of growth was roughly 40 percent. Such rapid growth is not unprecedented. The number of applications from South Korean inventors also increased at a yearly rate of roughly 40 percent from 1986 through 1996. In fact, using the South Korean experience as a guide, we should expect the number of Chinese applications to continue to grow steadily for the next decade (see Figure 13).

While the number of applications from China has increased over the past decade, so has the level of relative concentration of these applications in particular technologies. In particular, the share of applications in high tech areas such as computing, telecommunications, and electrical engineering grew from 50 percent at the beginning of the decade to 68 percent by the end of the decade. At the same time, the share of applications in biotechnology and chemical and material engineering fell from roughly 28 percent to 14 percent. Our historical analyses indicate that this was the continuation of a trend that had been ongoing since at least the mid-1990s. We found a similar result for other major emerging economies, where the share of computing and telecommunications applications grew substantially and the share of biotech and chemical engineering applications fell significantly over the same time period. The technology mix was more stable for applications from Japan and South Korea as well as for applications to the PTO from all countries (see Figure 5), indicating that we may expect a more stable technology mix for Chinese applications as the Chinese economy matures.

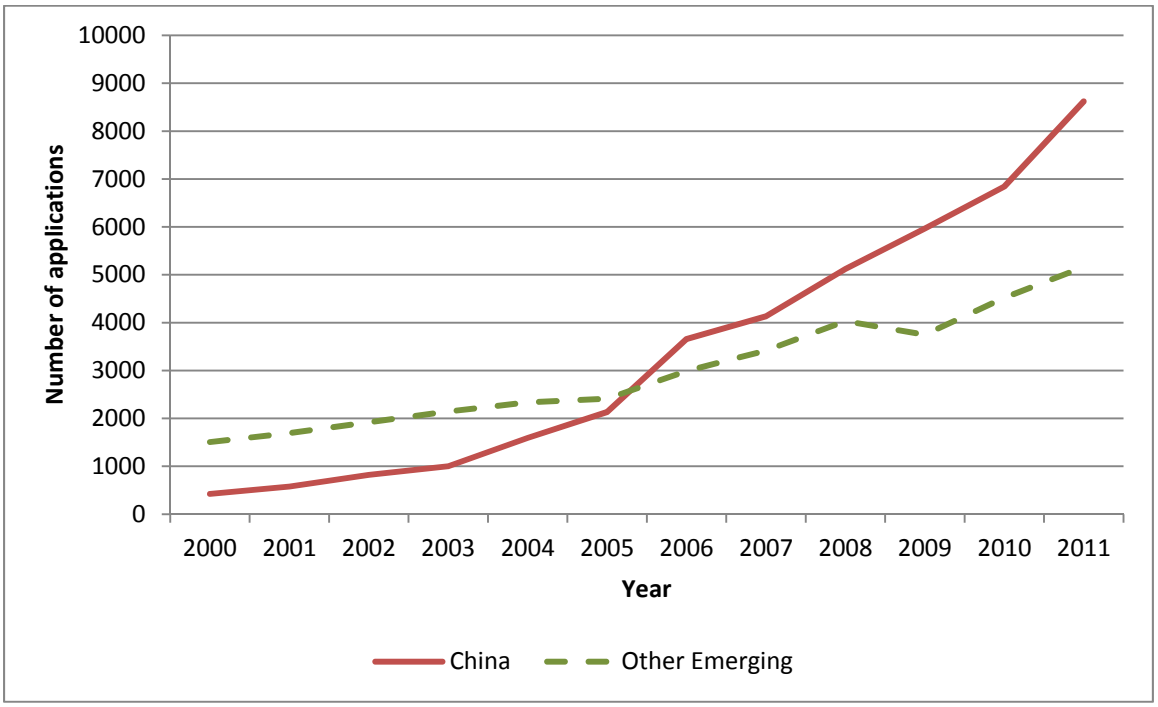
Finally, the allowance rate for Chinese applications has steadily converged toward the allowance rate of South Korean and Japanese applications over the past decade. For applications filed in 2000, the ultimate allowance rate for South Korean and Japanese inventors exceeded the allowance rate for Chinese inventors by 10 percentage points (82

percent versus 72 percent). For applications filed in the year 2010 and disposed by February 2013, the difference between the two allowance rates was only 1 percentage point (79 versus 78 percent). This may indicate that the mix of inventors has changed and that more applications are coming from Chinese inventors who are working for multinational enterprises, which have more experience with the examination of patents in the U.S. We believe that this would constitute an interesting avenue for future research.

Our analyses provide further evidence of innovative activities that are taking place on the Chinese mainland. In addition, the results imply that the Chinese are following a model that has been used successfully by their neighbors in South Korea.[24] The tremendous growth in filing at the PTO is not without precedent (see South Korea starting in the mid-1980s), but is unique in the current era. This growth, combined with improving allowance rates for Chinese applications, suggests that China is taking the next step in the development process from the production of standardized goods to the development of new products and processes.

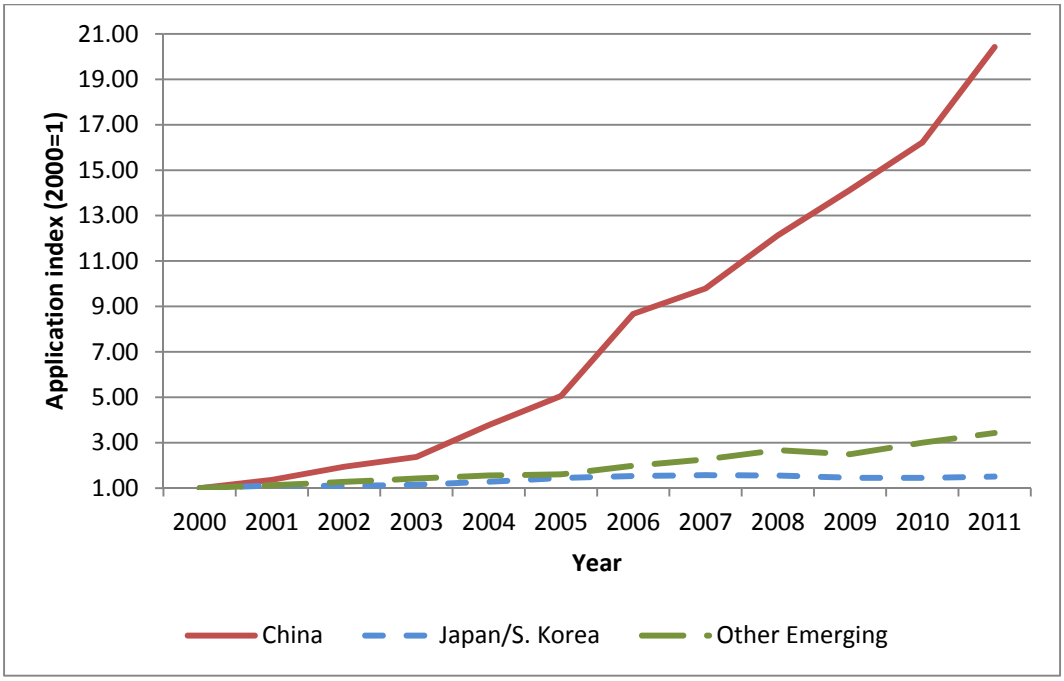
[24] Anecdotal evidence suggests a similar history for Japan, but the data to test this are not available.

Figure 1: Growth in the Number of Utility Patent Applications to the PTO from China and Other Emerging Economies, 2000-2011



Note: The other emerging group consists of Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey.

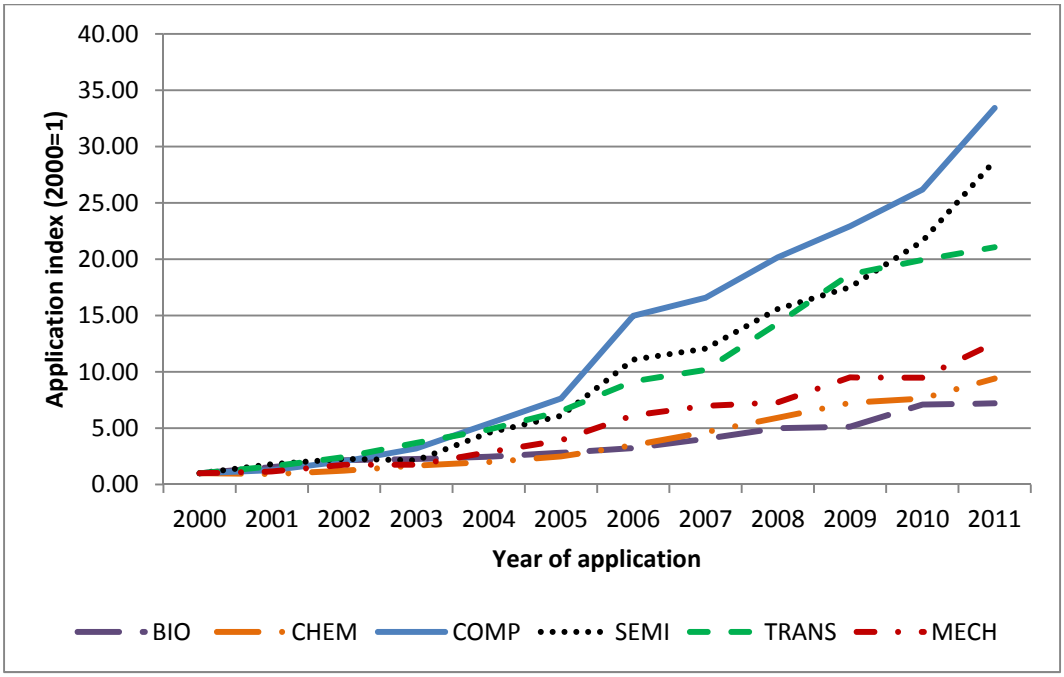
Figure 2: Comparing the Rate of Growth of PTO Utility Patent Applications from China to the Comparison Groups, 2000-2011



Note: The application index for a given year is equal to the number of applications received from the country or group of countries in that year divided by the number of applications received from the country or group of countries in the base year (2000).

Note: The other emerging group consists of Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey.

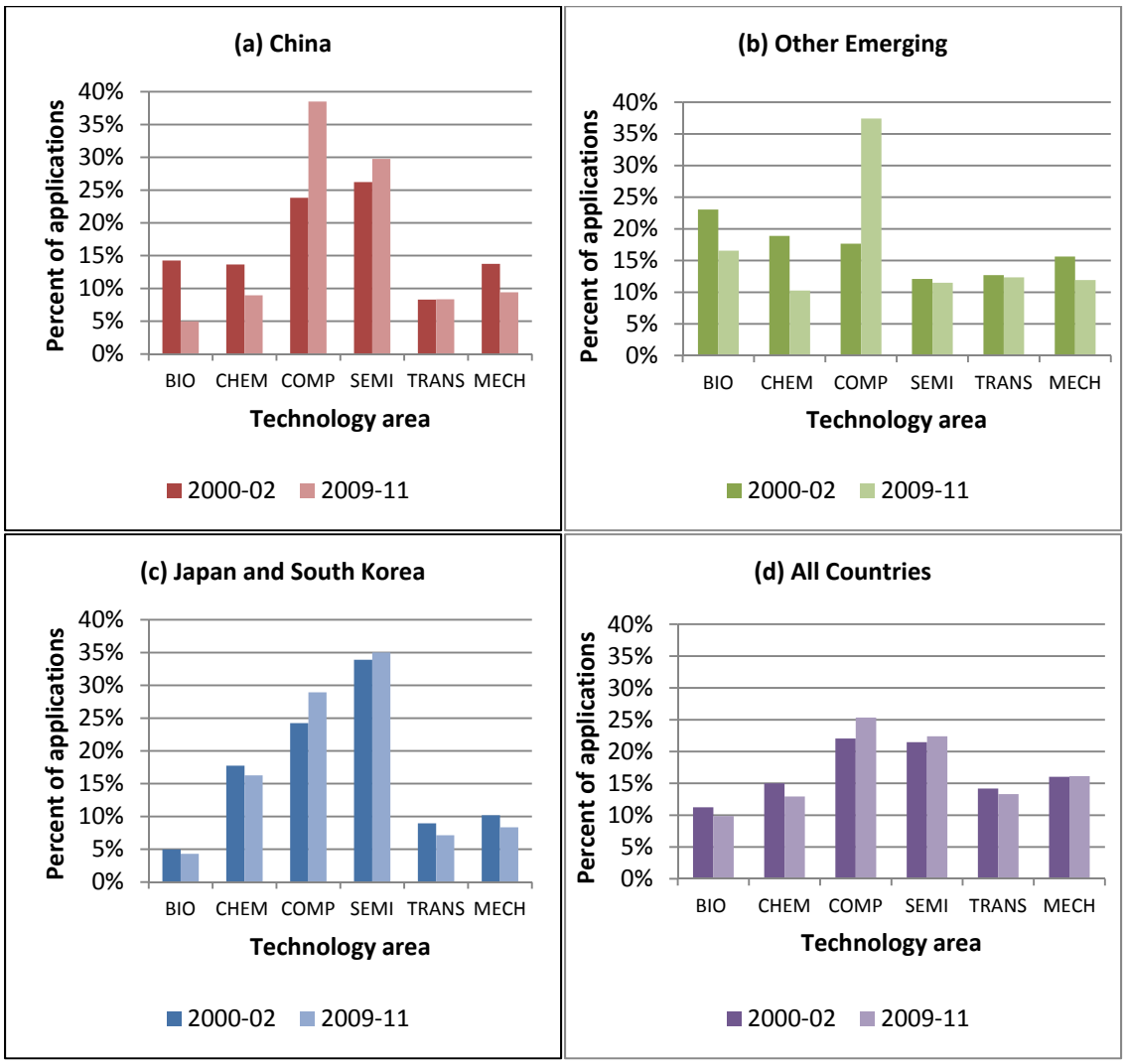
Figure 3: The Growth of PTO Utility Patent Applications from China by Technology Area, 2000-2011



Note: The application index for a given year is equal to the number of applications falling into a given technology category in that year divided by the number of applications falling into that technology category in the base year (2000).

Note: The technology areas are biology and organic chemistry (BIO); chemical and materials engineering (CHEM); computers and communications (COMP); semiconductors, electrical and optical systems and components (SEMI); transportation, construction, electronic commerce, agriculture, national security, and license and review (TRANS); and mechanical engineering, manufacturing and products (MECH).

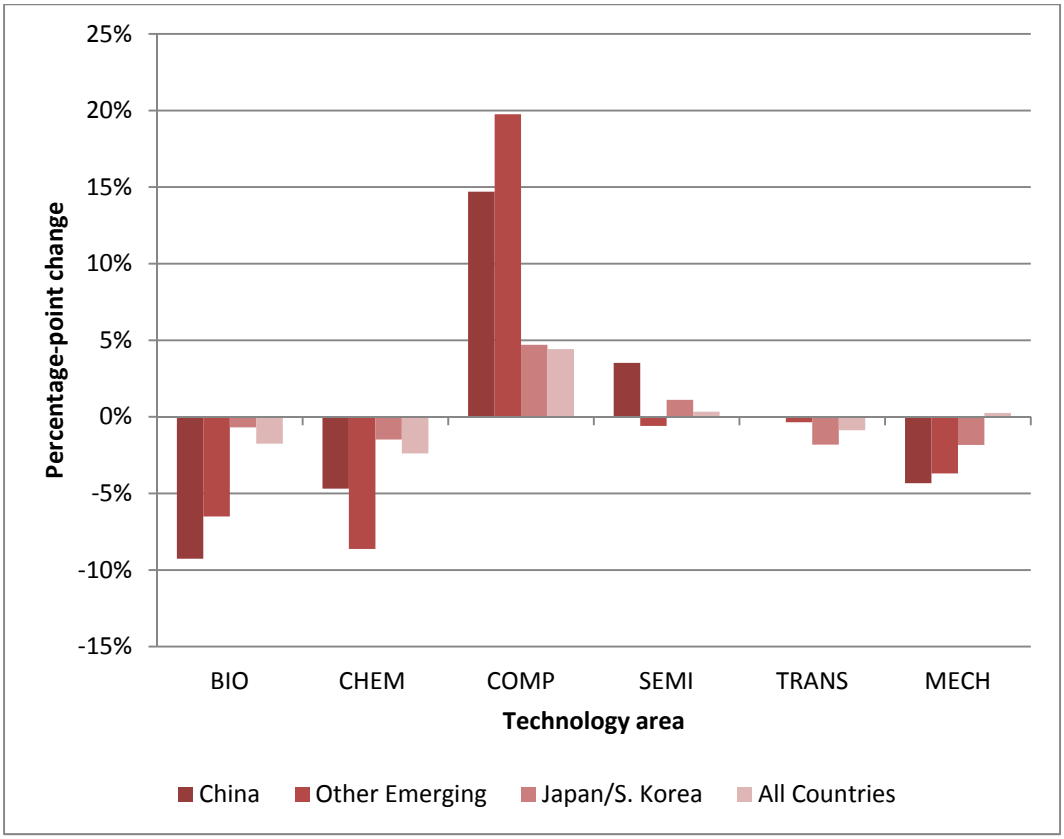
Figure 4: Change in Technology Mix, Applications to the PTO from Various Countries, 2000-02 to 2009-11



Note: The technology areas are biology and organic chemistry (BIO); chemical and materials engineering (CHEM); computers and communications (COMP); semiconductors, electrical and optical systems and components (SEMI); transportation, construction, electronic commerce, agriculture, national security, and license and review (TRANS); and mechanical engineering, manufacturing and products (MECH).

Note: The other emerging group consists of Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey.

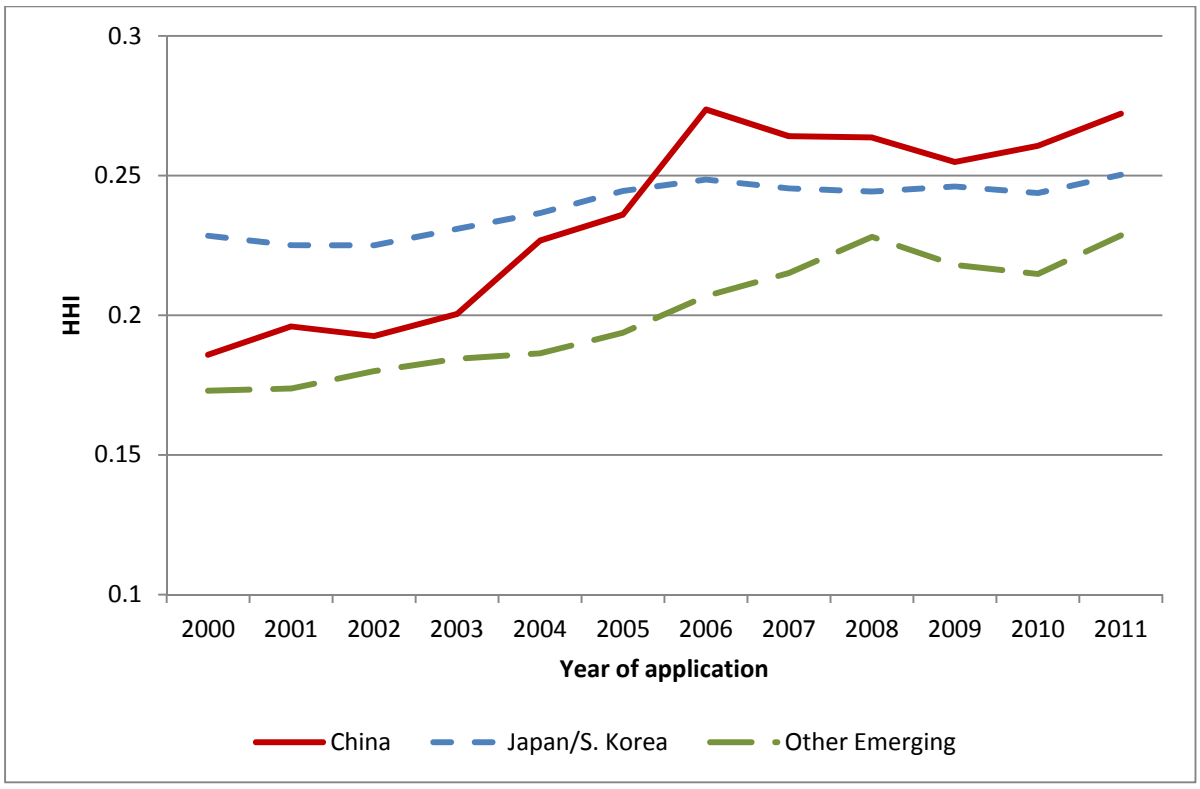
Figure 5: Changes in Technology Mix of Applications from China and Various Comparison Groups, 2000-02 to 2009-2011



Note: The technology areas are biology and organic chemistry (BIO); chemical and materials engineering (CHEM); computers and communications (COMP); semiconductors, electrical and optical systems and components (SEMI); transportation, construction, electronic commerce, agriculture, national security, and license and review (TRANS); and mechanical engineering, manufacturing and products (MECH).

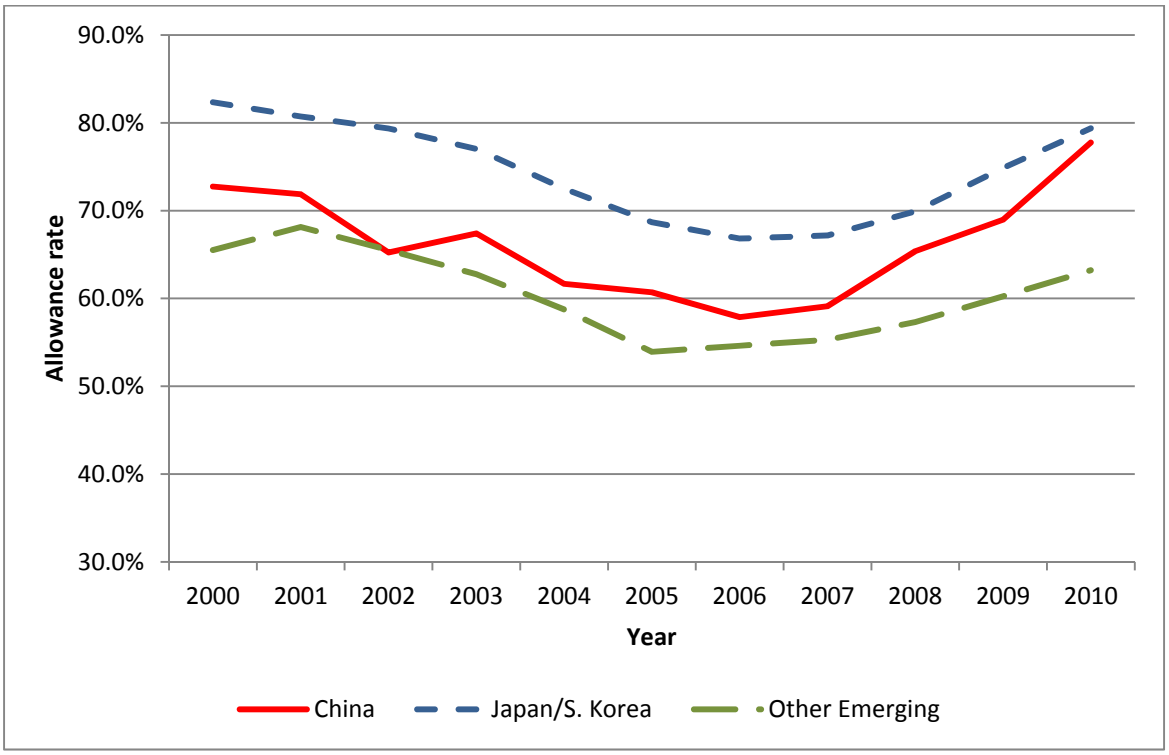
Note: The other emerging group consists of Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey.

Figure 6: Technology Mix Concentrations of Applications from China, Japan and South Korea, and Other Major Emerging Economies, 2000-20011



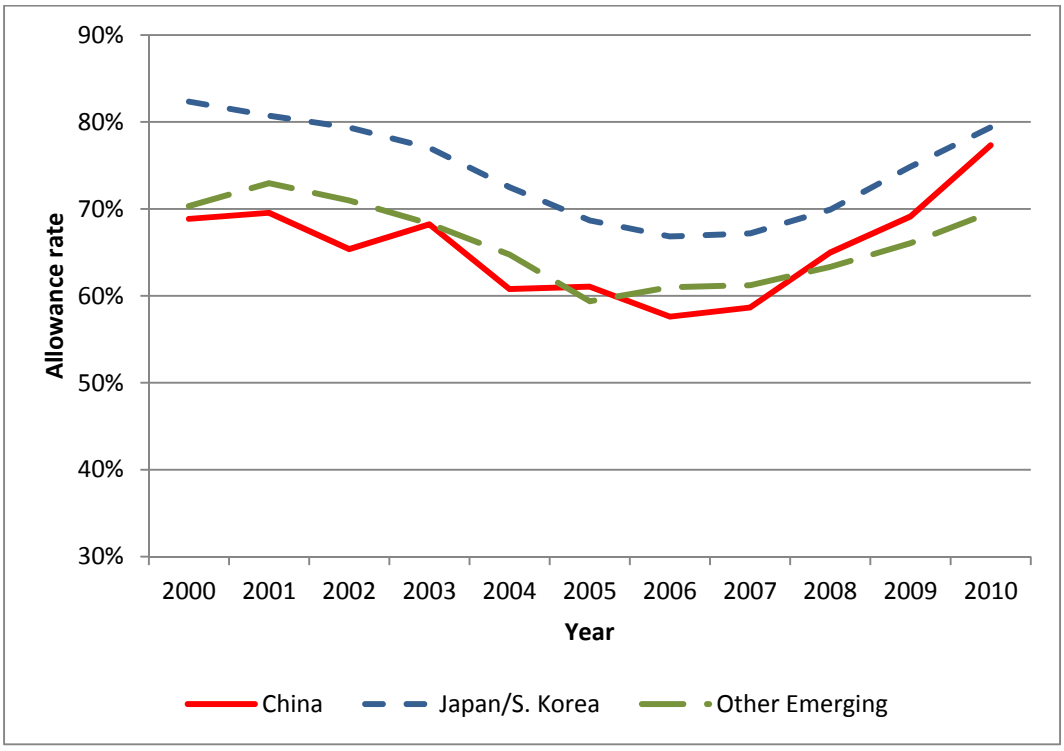
Note: The other emerging group consists of Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey.

Figure 7: Comparing Allowance Rates of Disposed Applications, 2000-2010



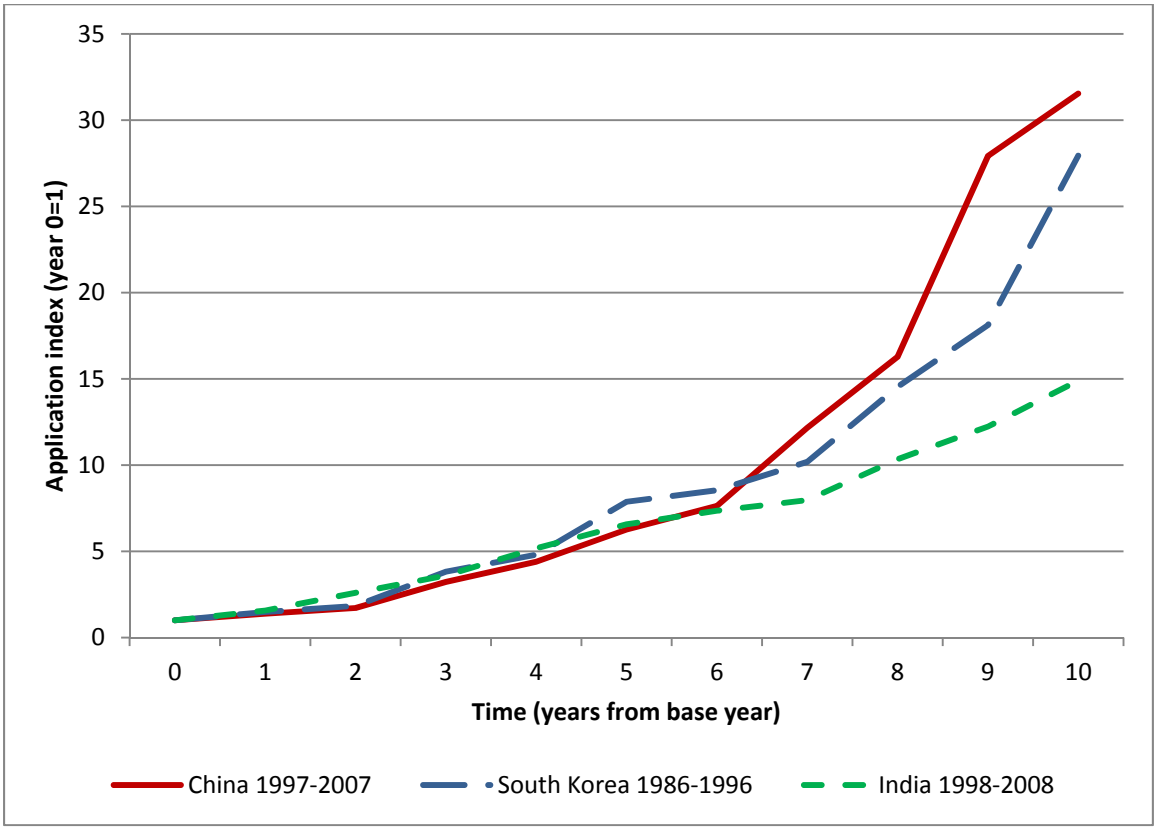
Note: The other emerging group consists of Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey.

Figure 8: Comparing Technology-Adjusted Allowance Rates of Disposed Applications, 2000-2010



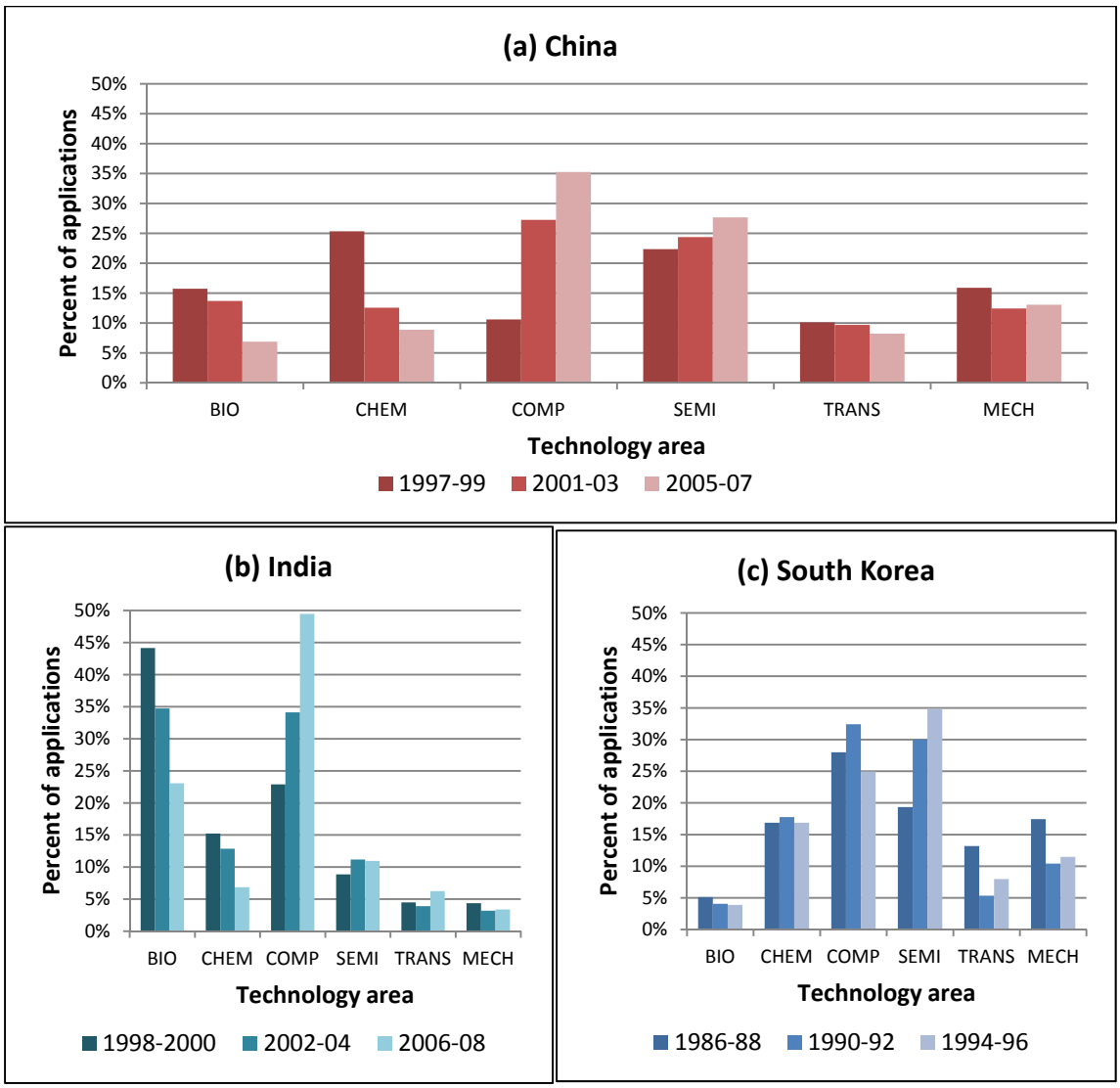
Note: The other emerging group consists of Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa, and Turkey.

Figure 9: Growth in Utility Patent Applications to the PTO from China (1997-2007), South Korea (1986-1996) and India (1998-2008)



Note: The application index for a given year is equal to the number of applications received from the country in that year divided by the number of applications received from the country in the base year.

Figure 10: Change in Technology Mix for Chinese Applications from 1997-2007 and for Comparison Groups



Note: The technology areas are biology and organic chemistry (BIO); chemical and materials engineering (CHEM); computers and communications (COMP); semiconductors, electrical and optical systems and components (SEMI); transportation, construction, electronic commerce, agriculture, national security, and license and review (TRANS); and mechanical engineering, manufacturing and products (MECH).

Figure 11: Change of the Concentration of the Technology Mix for Applications from the Three Countries and for All Applications (HHI Measure)

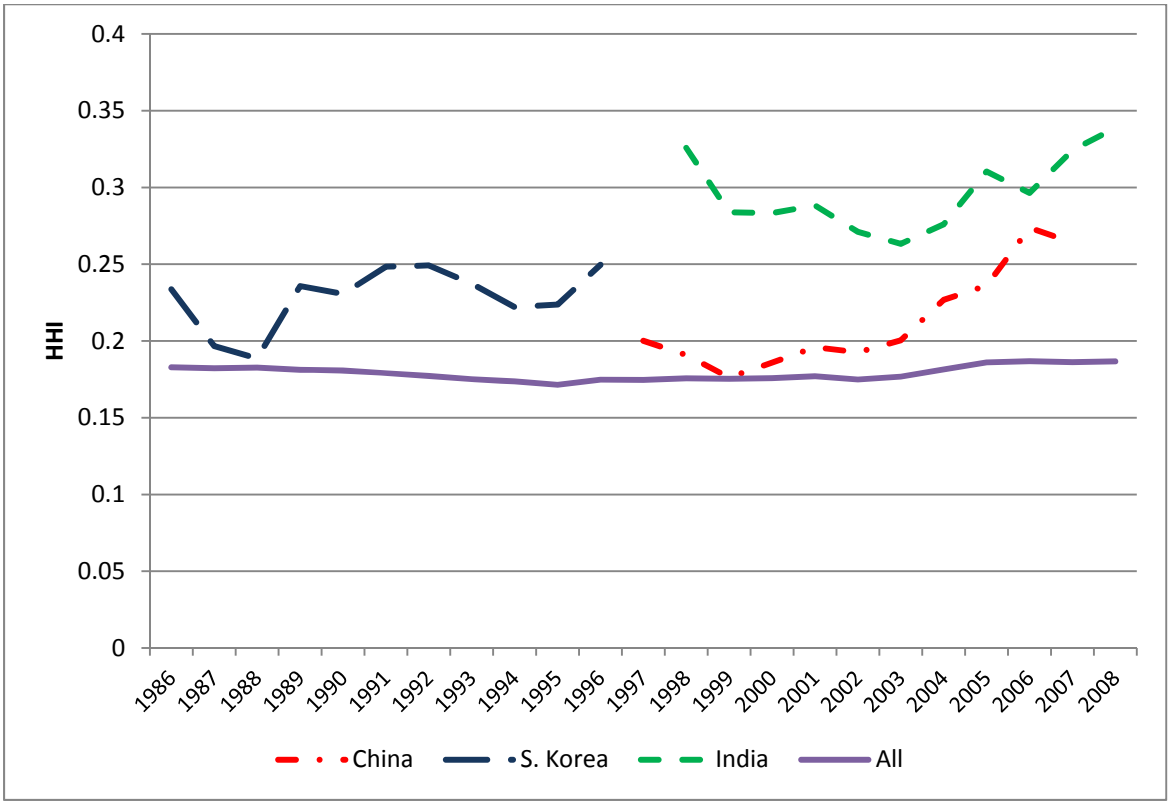


Figure 12: Comparing the Technology-Adjusted Allowance Rates for South Korea (1986-1996), China (1997-2007), and India (1998-2008)

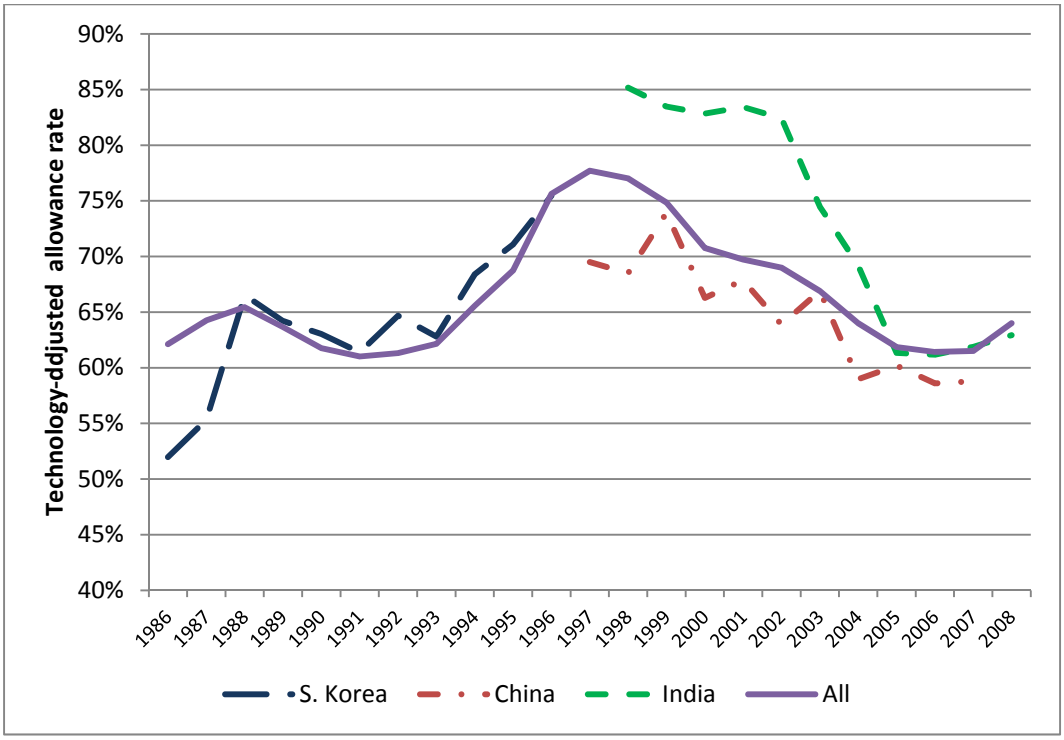


Figure 13: The Number of Annual Utility Patent Applications from South Korea (1986-2011) and from China (1997-2011).